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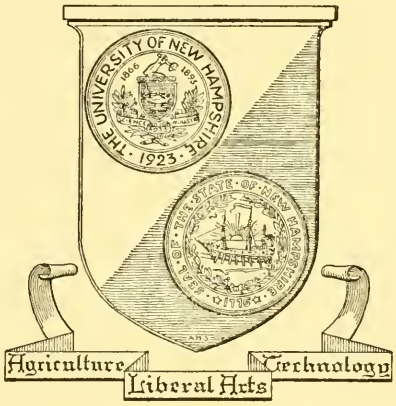

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Science IN NEW HAMPSHIRE AGRICULTURE

Annual Report of Director of New Hampshire Agricultural Experiment Station for the Year, 1936

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Agricultural Research in New Hampshire

Annual Report
of the
New Hampshire Agricultural Experiment Station, 1936
J. C. KENDALL, Director

It is sometimes difficult in year-by-year reports of experiments to catch the essential, underlying progress that becomes clear when we look back over a longer period. This is noticeably true now of our research work in New Hampshire soils. The soil survey, the laboratory tests and the field experiments are combining to make possible a picture of New Hampshire soils and soil needs which will be as far superior to that of a decade ago as a modern photograph is to a tintype.

Within the last few years, our knowledge of this basic field has been greatly extended and our facilities for coping with its problems have multiplied several times. Nearly half the state has now been definitely mapped as to the characteristics of its soil and subsoil in the cooperative survey conducted with the U. S. Bureau of Soils. Over a hundred classifications have thus far been used. The practical aspects of this work will become evident as the maps are published and come into general use. To say that a farm has so many acres of Suffield soil, for example, or so many acres of Agawam throws definite light on its capacity for hay and hoed crops. We know that the kame soils, Hinckley and Danby, are rather low in agricultural value because of their sandy nature, lack of water holding capacity and the necessity for heavy fertilization. Hadley and Ondawa, on the other hand, are highly productive for corn, hay and potatoes; Peru is one of the best pasture soils, though often stony; and so on.

In respect to the comparative values of some of the soils not much is as yet known, and further refinement of the entire field may be expected in future years; but we shall now have the basic information required for work.

Moreover, great improvement has been made in the last few years in laboratory technique as to determination of available plant nutrients in soils. Our fertility experiments in various sections of the state provided an opportunity to test these methods satisfactorily on soils whose treatment and response to fertilizers were known. Beginning in 1934 the Station has been able to make more definite recommendations as to fertilizer treatment and soil management from the study of submitted samples. As a consequence, the number of requests for such tests has steadily mounted, and this last year was 983, as compared with 150 three years ago.

The improvements in soil technique are not the only important advance. We have during the past year made detailed maps of local and district milksheds which give a more complete picture of milk marketing in the state than has ever before been possible. Similarly, maps of

present and potential rural electric lines with projected loads, the accomplishment of a cooperative survey with other state and federal agencies, have provided the basis for intelligent electric planning.

For eighteen years we have been most fortunate in having the close cooperation of Dr. Francis G. Benedict, director of the Nutrition Laboratory of the Carnegie Institution of Washington, in our studies of animal nutrition. Dr. Benedict's long experience in the field of human nutrition has been an invaluable asset in guiding and interpreting these studies. He has now reached the age of retirement, and it is with deep regret that our Station will lose his friendly collaboration and his scientific counsel, which has won international respect. Features of the metabolism research were made a part of the exhibit of the Carnegie Institution at its annual meeting in Washington and attracted wide attention.

Pullorum tests, already the highest in proportion to hen population among the states, jumped 55 per cent higher last year, following the new cooperative arrangement with the State Department of Agriculture. The record of samples reached 370,176—a third of the entire number of hens in the state.

A study of forest growth measurements has been developed north of the White Mountains in cooperation with the U. S. Forest Service, the Northeastern Forestry Experiment Station, and the State Forestry Departments of New Hampshire and Vermont. The investigation grows out of a need for standards of procedure to guide the newly formed cooperative of this region in periodic cutting and marketing of spruce and hardwoods on a sustained yield basis. A 10% cruise of the 140,000 acres of farm woodland in the area is well under way.

An important step was taken in the spring of 1936 when all the agricultural experiment stations of New England entered into a revised agreement with the U. S. Bureau of Agricultural Economics making possible a full time regional agent and providing for planning and carrying out regional programs of research in marketing and agricultural economics. As its first task under the new agreement the council is working on a research program concerning the marketing of dairy products in New England. The general purpose of the study is to discover possible improvements in marketing methods, practices and facilities and in methods of public control over milk marketing.

Few changes have taken place in personnel during the past year. E. H. Rinear, assistant in marketing research, resigned in February, going to the New Jersey Agricultural Experiment Station; and his place has been taken by Alan G. MacLeod. E. J. Rasmussen, assistant in Horticulture, left in the spring to take up similar work at the Michigan Station, and W. W. Smith has been appointed in his place. W. R. Gillette and J. Naghski have been appointed graduate assistants in botany; Miss Elinor Robison and Samuel Stevens, poultry laboratory technicians, the latter replacing R. C. Ham, who resigned in November.

H. C. Woodworth, agricultural economist, was on leave of absence, taking charge of the land use section of the Resettlement Administration in the northeast region, during the year.

Publications

Station Publications issued during the year were as follows:

Station Bulletin 285	Inspection of Commercial Feeding Stuffs, 1935
Station Bulletin 286	Results of Seed Tests, 1935
Station Bulletin 287	Twenty-five Years of Research
Station Bulletin 288	Inspection of Commercial Fertilizers
Station Bulletin 289	Station Report, 1935
Station Bulletin 290	Rural Real Estate Tax Delinquency in New Hampshire
Station Bulletin 291	Maintenance of Grade A Milk
Station Circular 49	Preparation of Bordeaux Mixture with Special Reference to the Use of Commercial Hydrated Lime
Station Circular 50	Fertilizer Experiments with Hay Crops in the Connecticut Valley
Technical Bulletin 62	Further Determinations of Oil Penetration into Insect Eggs—IX
Technical Bulletin 63	Penetration of Arsenic into Insects—X
Technical Bulletin 64	The Heat Production of the Sheep and Pig Before and After Castration
Technical Bulletin 65	Further Determinations of the Penetration of Arsenic into Insects—XI
Scientific Contribution 49	Variations in Yield of Pure Line Green Mountain Potatoes Grown in a Controlled Environment

Economic Pasture Study Started

An economic study was made by M. F. Abell this past year of 255 farms, on 115 of which pasture improvement work has started. On these farms, having 4975½ acres of open and 7324 acres of wooded pasture, and carrying 2425 animal units, 322½ acres were improved by top-dressing, 88½ acres by plowing and reseeding with fertilizing and 23 acres of effective clearing of brush,—a total of 434 acres, or 3.6 per cent of the total open pasture. This improvement together with some conversion of hayland into pasture, a slight increase in silage, more green feed, and an increase in annual pasture accounted for a reduced acreage of open pasture used per animal unit by .86 of an acre.

Open pasture per animal unit on the 115 farms where improvement work had been done averaged 2.05 acres, while on 140 farms without it open pasture averaged 2.91 acres per animal unit. (*Purnell Fund*)

Land Use in Back Areas

Processes that have within the last century shrunk a back-country area into agricultural insignificance are being made clear by the land-use study in southern Grafton County, in charge of H. C. Woodworth.

By means of detailed maps we can trace the decline from a period when this hill-region supported over a thousand farms, with a population of 4700 people as well as 5500 cattle and 21,000 sheep, until the

present, when the forest has engulfed all but 291 locations with a population of 883 people, 957 cattle and 167 sheep.

Small and difficult fields, non-inclusion of the territory by turnpikes and railroads, inaccessibility to markets and development of western agriculture have been principal reasons for the decline of the area.

Detailed records on 255 of the farms last year showed that 118 of them sold less than $50 worth of agricultural products. A great share of the income today comes from local tax sources, principally road work.

The chief resources of the area are forestry, and if the forest management could be adjusted to the labor of the community, it is believed that the land could still furnish productive work for a portion of the able bodied men. There could develop a pattern of small part-time farms grouped along the main highways in a commercial forest area, but this may not be possible without public ownership or some form of directed or controlled private ownership. Summer occupancy may also have a marked effect on developments in certain portions, and already summer sites more than equal the occupied farms in value.

Under practical farm conditions it is believed that the soil in the area can be maintained in yielding capacity only if related to livestock. Once the land has declined in yielding power, the expense in rebuilding it is usually prohibitive.

There is no exact information available to indicate the livestock required to maintain the land, but based on data from our study of forage production it is suggested that below .2 animal units per acre of tillage, the land is not maintained at a permanent level of production; that where from .2 to .5 animal units are associated with an acre of tillage, the maintenance of yielding power is doubtful; that where over .5 animal units are being kept per acre of tillage, the land should be definitely improved in fertility.

These are suggested as a rough guide and much depends on such factors as type of animal, amount of grain purchased, and management of manure and land.

A classification of present tillage land into groups as related to animal units indicated that about 49 per cent of the tillage land is depreciating, 45 per cent is being maintained, and 7 per cent is being improved.

Present management and use of tillage land seem to indicate the productivity of a large proportion of the tillage land will continue to decline. Tillage land not associated with livestock is likely to be in bush within the next 15 to 20 years. *(Purnell Fund)*

Fertilizer Placement on Potatoes

Accurate information is needed on the best placement of fertilizer with potatoes and particularly on the nature of fertilizer injury so that its importance in affecting potato stands may be better understood. In the experiments made during the year by Stuart Dunn the soil used was a fertile, heavy clay loam, the water content of which was kept at 60 per cent of saturation.

In one experiment whole seed and cut seed were used and the fertilizer was placed on the level with the seed piece in a circular band 2 inches

wide, the inner edge of which was 1¼ inches from center; *i.e.* as close to the seed piece as was practical without contact.

In the set of potatoes grown at mean temperature of 18-20° C., the rate of emergence of the fertilized plants was slower than that of the non-fertilized in a ratio of 1.57 for whole seed, 1.20 for apical seed, 1.18 for basal seed as contrasted with 1 for the non-fertilized seed. In the series grown at 14-15° C., the rate of emergence was approximately the same for both the non-fertilized and fertilized seed.

The growth of the plants at the time the first measurements were taken following emergence showed in every case the fertilized series smaller than the non-fertilized irrespective of temperature at which grown, but it was noticed at the same time that the longer emergence was delayed the less marked was the difference in the height of the plants. Eventually the fertilized plants outgrow the non-fertilized.

In another experiment the plants were grown at a mean temperature of 20.8° C. and the fertilizer was used at the same rate as in the first experiment, but two different placements with respect to the seed pieces were used. In one series the inner edge of the band of fertilizer was 1¼ inches from center, in the other 1¾ inches from center. The fertilizer placed close to the seed delayed emergence as in the other experiment, but the more distant placement was without noticeable effect. However, the amount of growth of the plants in both the fertilized series at the time first measurements were taken was less than in the non-fertilized series. Within the next seven days the growth of the fertilized plants in the case of the whole seed was greater than that of the non-fertilized plants, but in the case of the cut seed similar results were obtained only after the lapse of 14 days. (*Adams Fund*)

Bitter-Pit Less at Late Pickings

Evidence accumulates that bitter-pit develops in storage much less when apples are picked late in the season. Fruit from trees bearing bitter-pitted apples was stored and examined by O. Butler in January. Apples picked on October 1 showed 52 per cent having external symptoms developed in storage, whereas apples picked on October 10 showed only 6 per cent with external symptoms, and apples picked on October 21 and October 30 showed no external symptoms. In so far as internal symptoms are concerned, the percentage for the various stages ran respectively 0, 27, 66, and 9. (*Purnell Fund*)

Potato Mosaic Masked Under Favorable Conditions

In the study of the effect of place on mosaic and leaf-roll of the potato no loss of vitality was observed from one generation to the next in mosaic plants in spite of the fact that the seventh generation was grown in one set and the third in another. Mosaic symptoms appeared in the plants grown at 15° C. after the same lapse of time irrespective of previous history, and yields were lower than in the plants grown at 20° C. The increase in yield at the higher temperature is due to the more normal metabolism that accompanies masking of mosaic symptoms. The degree of masking is also affected very markedly by the

fertility of the soil or the type of fertilizer materials used. To illustrate, we have found that when mosaic tubers are planted on the one hand in a composted soil high in plant food elements, and on the other in a soil poor in essential food elements, but to which an 8-8-16 fertilizer was added at a rate equivalent to 1000 lbs. per acre, the cultures grown at 20° C. are very dissimilar in appearance. The plants grown in the poor soil to which commercial fertilizer was added possessed good healthy dark green foliage without recognizable mosaic symptoms, while the plants in the composted soil had light green foliage with characteristic mosaic markings.

Leaf-roll plants. The leaf-roll plants have almost completely run out. The seed pieces of the cultures grown at 20° C. all decayed, while 56 per cent of the cultures grown at 15° C. remained hard. Planting at 15° C. seed obtained from leaf-roll plants grown the previous year at 20° C. seems to be more injurious than the reverse operation, while the rate of deterioration of plants grown at 20° C. and 15° C. respectively is approximately the same.

From the studies on the effect of place we expect to obtain information that will be useful to the seed grower and table stock grower and permit one to ascertain from a perusal of weather records whether or not a given locality is suitable for seed growing. We are also accumulating information of value regarding the effect of climate on the symptomatology of leaf-roll and mosaic. The work is in charge of O. Butler. (*Purnell Fund*)

Bacteria Do Not Cause Ruptured Egg Yolk

Results of our bacteriological study indicate that bacteria are not the primary cause of ruptured egg yolk in New Hampshire flocks. In the etiological studies plate cultures were made from the organs, peritoneal fluid and yolk material of twenty birds with typical ruptured egg-yolk condition. Plain agar, meat infusion agar and meat infusion blood agar were used for isolation purposes, and the cultures were incubated both aerobically and anaerobically at 37° C. Thirty strains of bacteria were isolated and classified into four different species on the basis of their morphological, cultural and biochemical characteristics. These organisms were similar to the types identified in our previous studies. *Pasteurella avicida* could not be detected in any of the birds examined.

Pathogenicity studies gave essentially the same results as were previously reported. None of the species, when injected intraperitoneally into healthy laying birds, produced ruptured egg yolk. The work was conducted by L. W. Slanetz and C. L. Martin. (*Purnell Fund*)

Hemolytic Streptococci in Pasteurized Milk

In the hope that the studies on hemolytic streptococci will lead to the introduction and improvement in different methods of handling milk, work on their prevalence and classification was continued by L. W. Slanetz. Meat extract agar containing 1 per cent proteose peptone and 5 per cent sheep's blood proved to be very satisfactory for the detection and isolation of these bacteria.

Thirty-five cultures of hemolytic streptococci isolated from pasteur-

ized milk were selected for detailed study. They were found to be extremely heat resistant, some strains withstanding a temperature of 70° C. for 30 minutes. When stained from liquid media, they occur as long-chained streptococci. On blood agar, the colonies usually appear as the alpha-prime or weakly hemolytic type.

The following biochemical studies were made: fermentation reactions; final pH in glucose broth; hydrolysis of sodium hippurate, reduction of methylene blue; formation of soluble hemolysin; and digestion of human fibrin. Precipitin tests with group sera were also carried out. Up to the present time, the hemolytic streptococci isolated have been classified into three different types which do not appear to be identical with the other types of streptococci found in milk and described in the literature. (*Hatch Fund*)

Test Sprays for Apple Scab

Apple scab was more prevalent than for several years past in 1934 and a very good test was obtained by O. Butler of the relative value of fungicides under trial.

Ascospore discharge first occured May 8; that is, at the mid-period between the pre-pink and pink application. During the period May 1 to June 28 there were 17 rains with a mean precipitation of 0.20 inch and a range of .02 inch to 0.72 inch, and 10 spore discharges. In the spraying experiments Cal-mo-sul, sulsol, flotation sulphur, Kolofog and lime-sulphur solution were used. When an arsenical was required in the spray schedule, calcium arsenate was used with Cal-mo-sul, lead arsenate with sulsol and flotation sulphur; in the case of limesulphur solution and Kolofog, calcium arsenate was used exclusively on some plots, lead arsenate on others. In the plots sprayed with lime-sulphur and Kolofog it was impossible to detect any difference in the appearance of the foliage of the trees traceable to the arsenical used, and there was no fruit russeting. A summary of the data obtained is presented below for trees to which the pre-pink, pink, calyx and two cover sprays were applied.

Method of Treatment	*Total Scab*
	Relative Nos.
Trees not sprayed	100
Trees sprayed with Kolofog, 3 lbs. to 50 gallons	74
Trees sprayed with Cal-mo-sul, 10 lbs. to 50 gallons water	65
Trees sprayed with Sulsol, 1¼ lbs. to 50 gallons	60
Trees sprayed with Flotation sulphur, 4 lbs. to 50 gallons	26
Trees sprayed with lime-sulphur, 1 gal. to 50 gallons water	20

One cover spray did not give as good control as two cover sprays and three cover sprays were more effective than two, but in this connection it should be mentioned that the number of cover sprays required is not

affected by the season, but by the location of the orchard under treatment. If we assume that a spray program meeting the 90 per cent clean fruit standard with respect to scab is satisfactory, then experience shows that at a given station one cover may be completely satisfactory in four out of seven years, whereas in another it may never give the required control. Not only does the intensity of scab infection vary with the site, but evidence is accumulating showing that various points on any given site are likely to remain distinctly different as regards intensity of scab infection even through a succession of years. (*Hatch Fund.*)

Study Injury from Lime Sulphur Sprays

Experiments were continued by O. Butler on the relation of shade to spray injury from lime-sulphur. Previous results seemed to show that when shading increased the dry matter formed, injury was less marked, but during the present year we found in one instance shading increased injury, while in the other there was little or no difference, even though the dry matter formed was greater in the shaded plants. To test effect of soil moisture on growth and injury, beans were grown in soil containing water at 70 and 40 per cent saturation respectively. Beans grow very much better at the former saturation, but the injury due to spraying was not significantly affected.

Experiments were continued to test affect on tuber yield of spraying potatoes growing at mean temperatures of 20° C. and 15° C. respectively. The loss in yield at 20° C. was 5.30 per cent, at 15° C. was 9.75 per cent. When the experiment was discontinued the sprayed plants of the series growing at 20° C. were slightly more yellow than the non-sprayed, and in the cultures growing at 15° C. the differences were even more pronounced. To date no evidence has been obtained that the temperature at which the potatoes are grown has any direct influence on the loss in yield due to the spray.

Experiments were also continued to study the effect of number of applications of lime-sulphur on loss of dry matter. Previously we had found that the loss in weight remained practically constant irrespective of the number of spray applications given and this work was repeated. In one set of experiments beans were harvested, after 1, 2, 3, and 4 sprayings; in the other, after 1, 2, and 3 sprayings. The data secured while somewhat irregular, confirmed previous results. No evidence has been secured that lime-sulphur injury is cumulative. Experiments were also made to study the effect of spraying on the upper surface of leaves only, the lower surface only, and both surfaces. In the work apple and tomatoes were used. Spraying both surfaces caused most injury, and the lower surface was not found much if any more sensitive than the upper. (*Adams Fund*)

Soil Fertility Studies

Soil fertility experiments carried on over a period of years include: an experiment with hay on neglected haylands, an experiment with legumes on neglected haylands, an experiment with potatoes in a three-year rotation, a fertilizer experiment with legumes in the Connecticut

Valley, experiments with top-dressing old pastures, and a soil survey of New Hampshire. The agronomic work in the studies is conducted by F. S. Prince and P. T. Blood; the chemical phases by T. G. Phillips and G. P. Percival.

Hay on Neglected Haylands. The crop at the Whenal Farm in Greenland was top-dressed in 1936 and harvested according to plan in July. The treatments applied were: nitrogen alone, phosphorus and potash, and nitrogen, phosphorus and potash. The differences for all three treatments were positive, showing increases respectively over the check of 1057, 370 and 1343 pounds per acre. These differences are not so great as they were in 1935, reflecting lower rainfall.

Legumes on Neglected Haylands. One harvest only was secured on the 48 plots on the Whenal Farm. Although drought reduced yield and served to iron out variations between most of the series the stimulation of potash on alfalfa was apparent. It appears that at this stage of the experiment the continued use of 150 pounds of muriate of potash per acre increases the yield slightly more than one half ton of cured hay per acre no matter whether it is used alone or in combination with other fertilizer substances. Part if not all of this increase is due to the fact that potash influences the longevity of the crop, and more alfalfa persists where potash is applied.

The stand of alfalfa has become reduced on these plots to the point where it has been necessary to plow. The land will be planted in 1937 to an alternate crop before it is again seeded to alfalfa.

In another series where alfalfa is being grown without manure, the omission of nitrogen caused a decrease in yield in both cuttings, although doubling the nitrogen caused practically no difference in yield. Increasing the phosphorous and potassium content of the fertilizer brought considerable increase in yield. It appears on this soil that minerals other than nitrogen are extremely important. It also seems that with excessive minerals additional nitrogen is not so necessary.

Dairy Farm Rotation on Worn-Out Hayland. A three-year rotation of potatoes, oats and clover is in progress at the Lane Farm in Pittsfield. All of the fertilizer is applied to the potato crop, the oats and clover merely using any residue from the potatoes.

This is the fourth year of the test, and the first year in which potatoes have been grown twice on the same land.

Omitting the phosphorus and potash and leaving out the fertilizer altogether caused significant decreases in yield in the potato plots. Doubling the phosphoric acid and potash caused large yield increases that are not significant according to the statistical methods used. This is also true of the application of fertilizer in the hill and of the application of one-half ton of double strength material.

Lime at the rate of 500 and 1000 pounds per acre was applied two years prior to planting the potatoes. No scab developed on these plots in 1936, and the yields do not appear to have been affected by the treatment although the soil had an average reaction before treatment of about pH 5.3.

The only significant difference in the yields of the oats plots was for the series on which double strength fertilizer was applied for the potato crop. It is doubtful whether much importance should be attached to this result unless it holds true over a period of years.

Potatoes in a Three-Year Rotation. This experiment at the Jackson Farm in Colebrook is similar to the Lane farm test with all the fertilizer being applied to potatoes in a three-year rotation of potatoes, oats and hay. It has not been possible to secure a stand of pure clover on this soil and a mixture of clover and timothy is used. Excellent yields of potatoes were secured in 1936. On the check series, to which one ton of 4-8-7 fertilizer was applied, yields were 461 bushels per acre. The efficiency of high phosphorus on potato production was borne out by yields in the 4-16-14 and 4-16-7 series, which were 555 and 501 bushels respectively.

It is quite apparent that lime has no effect on potato yields in this experiment. Lime in the 4-8-0 series has consistently reduced potato yields over the plots which received no potash without lime due to the depressing effects of lime on potash availability.

The series receiving a mixed fertilizer with basic slag as the phosphorus carrier gave a significant increase, but the application of magnesium on the plots had very little effect on yields in 1936.

In the oats plots it is apparent that lime and residual phosphorus have had a significant effect on oats yields. Basic slag fertilizer also produced a significant increase, due probably to the fact that this material holds its availability over a longer period than superphosphate.

The lime variables on this experiment all gave significant increases in the hay crop. This will illustrate something as to soil acidity and makes the lack of lime response in the potatoes all the more remarkable.

Potato Scab Control. Tests on the limed plots in the potato rotation, legume and dairy potato rotation experiments show that some degree of control of scab may be obtained by the use of acidulating materials. On soils with a medium pH ratio scab seems to be associated with recent applications of lime, however small, which may leave spots of neutral or almost neutral areas within the soil mass. Soils with a pH of over 5.0 showed considerably more scab after recent applications of lime than those with a lower pH. As an acidulating material aluminum sulphate showed a slight superiority over sulphur.

Drilled Versus Broadcasting Fertilizer for Potatoes. A series of tests at the Whenal Farm in Greenland to determine the relative merits of drilling and broadcasting fertilizer for potatoes showed an increase of 25 bushels per acre in favor of the drilling placement.

A Fertilizer Experiment with Dairy Farm Crops in the Connecticut Valley. The results of seven years' experiments on the Livingston farm near Claremont are outlined in detail in Station Circular 50, published this year.

The entire field embracing 80 twentieth-acre plots was plowed and planted to Canada Leaming corn in 1936. The fertilizer schedule was not changed for the various series except that no fresh lime was applied. Manure was spread as a basic application on all plots.

Silage corn is the first crop grown on these plots which has given larger differences with superphosphates than with potash.

In general the plots that received manure and phosphoric acid as variables gave significant differences, while potash used by itself had very little effect upon corn yields. This would indicate that corn either is not so responsive to potassic fertilizers or was able to extract its potash requirements from the manurial application.

Top-Dressing Old Pastures. In the 18 plots conducted on the Seavey pasture, Greenland, the application of superphosphate and potash appears to be stimulating growth more than during the first three years of the test. White Dutch clover made its appearance on such plots in 1935 and has become more abundant in 1936.

The nitrogen carriers for 1935 ranked in the following order in stimulating production: nitrate of soda, sulphate of ammonia, cyanamid. For the complete fertilizers the cyanamid basic slag mixture gave the highest yields.

Similarly, in 18 plots conducted on the Livingston farm near Claremont, the average yields of 5 nitrogen carrier plots in 1935 amounted to 394 pounds of protein per acre, whereas the average of four complete fertilizer plots was 579 pounds protein.

The nitrogen carriers in this test ranked as follows in 1935; nitrate of soda, calcium nitrate, cyanamid, cal nitro, and sulphate of ammonia.

Practically no clover appears on the plots where nitrogen alone is applied, but phosphoric acid and potash, or one of these elements with nitrogen, bring in abundant clover a few weeks after treatment. The clover response to minerals on this soil is perhaps the most remarkable thing about the test, and the method of fertilization is applicable to a large specialized dairy farming section of New Hampshire. (*Purnell Fund*)

A Soil Survey of New Hampshire

The soil survey of New Hampshire, which was started in 1935, was continued in 1936 in two areas—Sullivan County was completed, and Cheshire County is about one-third completed. About one half of Coos County was surveyed in 1936. The work in Cheshire County was done by C. S. Simmons of the U. S. Bureau of Soils, assisted by W. H. Lyford of our staff. The Coos survey was under the supervision of B. H. Williams of the Bureau of Soils assisted by W. H. Coates of our staff. The Grafton County survey, which was completed in 1935, will be published shortly. The Sullivan and Cheshire surveys will be published together after the Cheshire area has been finished. (*Purnell Fund*)

Grass Hay Top-Dressing

That the date of applying nitrate of soda makes considerable difference in yield is shown in the study conducted for three years by F. S. Prince and P. T. Blood on the Mathes field at Durham. Applications of 200 pounds on April 5, April 15 and April 25 yielded respectively averages of 1207, 1762, and 1977 pounds per acre. Apparently the earliest application was leached before the plants had an opportunity

to utilize it. The check plot with no treatment at all yielded 1253 pounds.

Complete fertilizers on similar plots yielded about 800 pounds more per acre than nitrogen carriers alone.

Spring treatment with either nitrogen or complete fertilizer considerably out-yielded fall treatment except that with cyanamid there was relatively little difference. Response from phosphorus seems to be greater than from potash on these soils. (*Hatch Fund*)

Time of Cutting Hay

The plots started in 1930 are still being kept in their original location to determine the continued effect of cutting at different dates on timothy stand.

There is some variation in yield from year to year due to rainfall, report F. S. Prince and P. T. Blood. There is also some variation from year to year in protein percentage, but the data within the year has been remarkably consistent.

Cuttings every ten days from June 10 to July 30 showed decreasing yields in pounds of protein per acre, ranging from 210 to 140 pounds. This is in spite of the fact that the total yield of hay per acre increased from 2008 to 2891 pounds. (*Hatch Fund*)

Corn Variety Test

Forty-nine corn varieties planted on the Ireland farm in Greenland in 1936 showed descending weights ranked as follows: Improved Leaming, 21.78 tons, green weight per acre; Early Eureka Ensilage, 20.96 T; Sure Crop (Originator's strain), 19.43 T; Tuxpan, 19.30 T; Pamunkey Ensilage, 19.29 T; Virginia Eureka, 18.77 T; Kato, 18.06 T; Southern Hybrid Sweepstakes, 17.88 T; Canada Leaming Hybrid, 16.81 T; Golden Queen, 16.19 T. The work was in charge of L. J. Higgins. (*Hatch Fund*)

Metabolism of Lactating Cows

The physiological phase of the nutrition studies conducted by E. G. Ritzman in cooperation with F. G. Benedict of the Carnegie Institution of Washington was continued with a study of the basal metabolism of the dairy cow when secreting milk, the object being to determine the effect of this lactation on tissue stimulus. In four respiration experiments with two cows the daily heat production was a little over 10,000 calories on the fourth day of fast. Previous to the fast each cow was yielding slightly over 10 kgs. of milk, but on the fourth day without food when they had reached the fasting state the secretion of milk had almost ceased. This suggested that secretion of milk involves a stimulus not only of the lactating gland, but also of the body tissue in general. (*Purnell and Miscellaneous Income Funds*)

Balanced Rations for Dairy Cows

Five complete balances were carried out with two lactating Holstein cows to determine the adequacy of protein and more particularly of

energy as provided by some of the feeding standards now in common use. This study by E. G. Ritzman and K. S. Morrow in cooperation with F. G. Benedict of the Carnegie Institution, forms the beginning of an investigation on the adequacy of present standards for feeding lactating cows. The cows used in this initial step were two large framed Holsteins supplied by the dairy herd and the rations fed were calculated on the basis of the Morrison standards.

The result, which represents only a stage well advanced in the period of lactation, cannot at present be assumed to apply to the entire period. However, several significant facts may be reported at this time.

In all five experiments, computed by accepted standards, there occurred a minus balance in energy. An outstanding feature also appeared in the extraordinary low utilization of the digestible crude protein (as indicated by the high nitrogen content of the urine) in three out five cases. There is strong evidence to indicate that the high nitrogen content of the urine was partly the result of a katabolism of body protein to meet the energy deficiency in the ration.

The general picture so far suggests the tendency to underfeed in energy and possibly to supply an excess of protein for cows whose inherited tendency to secrete milk has definite limits. (*Purnell Fund*)

Nutrition of Horse, Pig and Goat

Measurements of the heat production of a Percheron stallion and of a Thoroughbred stallion carried out during the year by E. G. Ritzman in cooperation with F. G. Benedict, indicate a much higher basal metabolism per unit of size in the more active racing type.

Four basal metabolism experiments were carried out on one adult Chester White boar weighing 235 Kilos. and on one adult Chester White sow weighing 113 Kilos. The result, expressed on a basis of heat loss per square meter surface area (using the formula $10.W^{2/3}$) shows 980 calories for the sow which practically equals previous results obtained on two Berkshire sows. The Chester White boar, on the other hand, shows a basal heat production of 1600 calories per square meter of surface area. Whether this represents entirely a difference of sex seems improbable.

Experiments were also carried out with goats and with sheep to study the zone of thermic neutrality of these species, their relative reactions to changes in environmental temperature, and the effect of their body covering on heat loss and heat production. These studies form the beginning of a research on the validity of the theory that basal heat production is determined by rate of heat loss and that all warm-blooded animals regardless of species give off heat in direct proportion to their surface areas and at an essentially constant rate. (*Adams Fund*)

Sheep Breeding

Some further progress has been made during the year by E. G. Ritzman toward establishing a flock of sheep with the functional capacity of four nipples; 75 per cent of the ewe flock now have from three to five functional nipples. This has been due to the addition of fifteen yearl-

ing ewes to the breeding flock, thus eliminating some of the older parent stock. The large proportion of young ewes dropping their first lambs has, however, caused a drop in the percentage of twins for the flock as a whole, as only one of these yearlings dropped twins.

One of the unanswered common results that has always perplexed sheep breeders is the fact that in some years twinning appears to be much more common than in others without any apparent reason explainable on the basis of present knowledge. From many years of experimentation in studying the metabolism of sheep it has been found that a low level in heat production occurs during November and December, or in other words, during the early development of the fetus; and it seems quite possible that this low twinning rate may be somehow associated with the low metabolic activity which prevails at this time.

An outcross has been started by mating a four nippled Suffolk ram (from imported stock) to 21 yearling ewes all of which are four nippled. The result will no doubt increase the size somewhat without retarding the four-nippled trait, and it is expected to improve the twinning tendency.

One of the most gratifying results of this work has been the constant improvement in the character of the wool, particularly in its adaptability to market requirements. As judged by expert market graders this wool has the strength and length of ⅜ blood staple with the tone and spinning qualities of ½ blood, which places it well at the top of fleece wool. *(Adams Fund)*

Contact Insecticides

Investigations of criteria for laboratory appraisal of wetting and spreading performance of spray materials have been completed and prepared for publication by W. C. O'Kane, J. G. Conklin, L. C. Glover and W. A. Westgate. The criteria studied are seven in number as follows:

(1) The exposure period as defined in a previous report; (2) time required for individual droplets of a spray to coalesce and wet a surface; (3) angle of contact liquid-solid; (4) adhesion tension; (5) surface tension of liquid; (6) spreading coefficient; (7) area of spread.

In general, the materials studied arrange themselves in the same order when appraised by these various criteria. There are some exceptions, however. For example, angle of contact may give erroneous results unless angles are read at successive time intervals, in order to disclose the behaviour of a droplet upon standing.

Studies of effects of spray pressure disclose this to be an important factor in the performance of a spray material.

Investigations have been continued on the penetration of arsenic into insects, and resulting distribution of the poison in various structures and organs. Results of some recent studies were published in June, 1936, in Technical Bulletin 65, "Further Determinations of the Penetration of Arsenic into Insects." This is No. XI in "Studies of Contact Insecticides." *(Purnell Fund)*

Insect Record

Four unusual insect problems arose during the year, report W. C. O'Kane and J. G. Conklin.

In order to secure important information as to possible carriers of the Dutch elm disease in New Hampshire, investigations were begun as to the presence of the beetles that might carry the disease. In cooperation with the State Division of Insect Suppression trap logs were placed in seventy-two localities. These logs were examined in detail and a record was made of insects found in the logs. No specimens of the European elm bark beetle were recovered. In two localities a native bark beetle was found. Various elm insects were recovered. It is planned to continue and extend this work the coming season.

In the spring of 1936 extensive defoliation of blueberries took place in southern New Hampshire. The insect was identified as the blueberry spanworm, *Itame inceptaria*. This pest was recorded only once before in New Hampshire, in 1886. The present outbreak was serious and resulted in substantial destruction of the blueberry crop over large areas. Studies were made as to the life history of the insect, concerning which little is known.

An outbreak of the so-called Surinam roach, *Pycnoscelus surinamensis*, occurred in a greenhouse which raises large quantities of roses. The outbreak was severe and resulted in destruction of several thousand plants. This roach burrows in the ground and remains hidden during the day. At night it comes out and strips the plants, including the epidermis from the stems. Application of arsenical sprays gave no control, but the department succeeded in securing a high degree of control by application of a special nicotine spray to the soil.

The past summer delphinium plants in the southern part of New Hampshire were seriously injured by the so-called broad mite, *Tarsonemus latus*, which has not hitherto been reported from the state. Leaves of plants attacked are twisted and deformed. Flower buds are stunted. Heavy applications of sulphur dust were found to be the best remedial measure. (*Hatch Fund*)

Heat Requirements for Brooding Chicks

Following the indications from the previous year's work that insulation in the brooder house in either walls, ceiling or floors produced no appreciable improvement in operating characteristics of the brooders, attention this year was directed toward the conditions close to the brooder unit. The constant presence for the past two years of a ring of moisture in the litter just outside the edge of the brooder indicates that this is the dew point and therefore, the outer extremity of the area where temperature is to be controlled.

Extensions 12 inches wide were made of plywood and attached to the outer edge of each brooder with an additional curtain at this point, thereby increasing the cubic contents, floor area and outer rim protection for each brooder. Temperature variations under the brooder were thus considerably reduced, for the most part being held within a 10° F. range.

In order to determine the amount and effect of floor drafts, several types of artificial floors were placed under the brooders:—elevated wire mesh, raised floor pad and floor pad with heating elements. Of these, the elevated wire mesh floor showed erratic and great changes of temperature. The same characteristics, with some modifications, appeared in the case of the raised floor pad (½" off floor) in previous years. The floor pad giving under heat showed the greatest effect in stabilizing temperature, maintaining a 5° to 7° regulation, which is somewhat better than that gained with the extension rim on the hover.

Reviewing the comparative value of (1) housing conditions and, (2) brooder design and characteristics as affecting the regulations of temperature under the brooder, the past three years' results indicate that, of these two factors, the second is the more important.

The chicks under the three brooder conditions, namely, heat pad, raised wire floor and brooder extension, averaged to weigh over one pound at six weeks of age—practically the same in all groups. Only slight differences in total feed consumption between groups were noted. In the brooder extension group the average mortality was 3.3 per cent for the six week experimental period. The other groups, brooder plus raised wire floor and brooder plus floor heat pad, showed 2.07 and 2.03 per cent mortality, respectively.

The average total consumption of electricity required for the groups brooded with the use of floor heat pad was 483 kw. hrs., of which 123 kw. hrs. were consumed by the floor pad. Adjustment for the amount of top heat was not made to allow for extra heat provided by floor pad. In the groups with raised wire floor the average consumption was 457 kw. hrs. In the case of the brooder extension groups the average consumption was 361 kw. hrs. The average total kilowatt hours per chick for the three conditions listed was 2.276, 2.149 and 1.703 respectively. The work was conducted by W. T. Ackerman, T. B. Charles, G. M. Foulkrod, A. E. Tepper, and R. C. Durgin. (*Purnell Fund*)

"V" Belt for Power Grindstone

As a supplement to the work done in 1934 on "Electric Power for the Grindstone", a "V" belt drive adaptable to the conventional farm grindstone was developed by W. T. Ackerman and G. M. Foulkrod. (Station Circular No. 43).

A used commercially built grindstone, 2½"x24" stone on a typical four leg wood frame, designed to be driven by either a hand crank or treadle was secured.

A small, two bearing, grinder head was purchased for $1.86 and mounted on one end of the frame. The belt pulley in the center of the grindstone head had a 2½" face, was 2½" in diameter, and could be driven with either a "V" or flat belt.

A 48" "V" belt was run to a 10" pressed steel "V" pulley, (cost $1.20), placed on the grindstone axle.

The motor, a ½ h.p., 1725 r.p.m., was mounted on a wooden frame hung by metal straps so it hinged on a rod through the two legs, about 4" from the floor. A "V" pulley 1¾" diameter, (cost $.35) on the

motor was then connected by a 58″ "V" belt, (cost $.85) to a 6½ "V" pulley, (cost $.80) mounted on the inside arbor of the grinder head. On the other arbor of the grinder head a 1″x8″ carborundum stone, (cost $3.45) was installed.

The proper tension on the V-belt was provided by allowing it to support the weight of the motor which was suspended from a lower crossbar between the legs of the frame by a strap hinge arrangement. A screw attached to the motor platform and made adjustable with a lock-nut under the platform, provided for raising and lowering the motor to decrease or increase the belt tension according to need.

By this drive the 1725 r.p.m. of the motor is reduced to about 500 r.p.m. on the grinder head on which the carborundum stone is mounted, and again reduced to about 83 r.p.m. at the grindstone. If this is too fast operation, a bit larger, 8″ diameter or even 9″, pulley on the inside arbor of the grinder head will provide speed correction.

The total cost of the remodeling exclusive of labor and motor was less than $8.00.

The advantage of this type of unit is dual-purpose grinding equipment, carborundum wheel and grindstone, on which rough grinding and finishing can both be accomplished. The "V" belt drive is both quiet, steady and positive. (*State Fund*)

Wax Heating Equipment for Poultry Dressing

Inability to locate commercially made wax-heating equipment suitable for dressing poultry in small batches, caused the design and construction of a unit for test and demonstration.

To simplify the equipment, reduce the initial cost, and, at the same time, present a design that poultrymen might duplicate themselves, materials that could be easily secured were employed by W. T. Ackerman and G. M. Foulkrod.

An ordinary galvanized 12-quart pail was used as a receptacle for the wax. This was arranged to fit into the round, open top of a 5-gallon electric dairy hot water heater of 1,000 watts capacity at 110 volts. Several makes of this type are on the market. This method makes use of the double boiler principle which is valuable to maintain a steady wax temperature, simplify the temperature controlling mechanism and reduce the fire hazard. (Extreme care should be exercised in heating wax over open flames.) A mercury bulb thermostat with the bulb placed in the wax was used as a controlling device.

The thermostat once set for the desired temperature of the wax will operate on about a 1 degree temperature variation, and the water bath, responding rapidly to the large heating element, keeps the wax within a degree of the desired temperature under normal use for a small number of birds.

Equipment of this type may be used for either scald picking or wax picking. A fan was found to hasten drying after scalding, and between dippings of the fowl in the wax. (*State Fund*)

Electrical Washing and Sterilizing Equipment for Dairy Utensils

One new combined water heater and dairy equipment sterilizer tested showed many desirable qualities, but indicated a necessity for a better efficiency and control of the time element in the sterilizing action, report W. T. Ackerman and G. M. Foulkrod.

Operating as a 5-gallon water heater it showed results somewhat comparable to many others on the market. Five gallons of 52° water were heated to 192° in 47 minutes before the current was cut off by the thermostat, consuming 2.14 Kilowatt hours. Two hundred degrees Fahrenheit was reached in 55 minutes without further current consumption. This is at the rate of .43 Kilowatt hours per gallon of 52° F. supply water or 150° temperature change.

As a sterilizer for one can inverted over a steam generating nozzle, steam started in 5 minutes, but 15 minutes was needed to get any part of the can up above 150° F., while at 17 minutes the automatic switch shut off the power and no higher temperature could be reached.

As a sterilizer for miscellaneous equipment, and with the compartment filled to capacity, the highest temperature recorded was 163° F. in 20 minutes. At this point the switch cut off the power and the cooling off started.

To obtain higher temperatures and increased efficiency, the sterilizing tank was insulated, the steam more uniformly distributed, and a manual control switch used to extend the period of operation.

Steam started in 5 minutes and at the end of one hour and 15 minutes the entire tank and contents reached a uniform and peak temperature of 205° F., showing that insulation and a change in control design would produce more effective action.

The time needed for arriving at sterilizing temperatures and holding at these temperatures seem to be the main drawbacks to this equipment. The average farmer cannot afford to and will not wait too long a time to sterilize a can or other equipment. (*State Fund*)

Electric Fence Controller

Tests conducted since April, 1935, on a commercially made electric fence controller designed to operate on 60 cycle, 115 volt, A.C. service, indicate this as a very satisfactory method of temporary enclosure for several kinds of farm animals.

It was found that the electric current intermittently sent over the fence wire was under a pressure of 90 volts, and that the amperage was exceedingly low—.08 amperes—so that the shock received when the fence is contacted is not injurious to livestock.

The current consumed was 5.4 kilowatt hours per month of continuous day and night operation. A single strand of barbed wire attached to posts 50 feet apart and at about ⅔ of the height of the animal from the ground was necessary. One strand of wire—placed from ⅔ to ¾ of the height of the animal—was satisfactory for hogs. With sheep, two strands of wire were required at 15 and 28 inches, respectively, from the ground to secure complete enclosure.

It was found difficult to enclose goats unless three strands of wire were employed, and this was deemed impractical. In all tests made the total length of wire was somewhat less than ½ mile. It was found particularly essential to see that the wires were properly insulated on the posts and protected from shorting to the ground.

Farmers are warned to use electric fencing only with controlling devices of approved design, and in no case to attempt to build their own, or to place the usual household electric current directly on any exposed wires. The work was done by W. T. Ackerman and H. N. Colby. (*State Fund*)

Alarm System on Poultry Fencing

The burglar alarm systems, described in Extension Circular No. 171, presuppose that the poultry is housed. Many poultrymen, especially turkey growers, have found they were losing birds from well fenced ranges. Tests were made by G. M. Foulkrod to determine the practicability of connecting the range fence into the conventional alarm circuit.

The turkey range at the University Poultry Plant was wired by stretching a single strand of No. 28 enameled wire around the entire fence line. The wire was fastened by taking a single turn about all metal posts and stapling to the wooden ones, keeping it about two to three inches above the top of the woven wire. The ends of this loop were connected through a transformer to the closed circuit alarm panel already installed. The ends of this loop were connected in series to the conventional closed circuit alarm system already in place.

If the wire is broken by prowlers climbing the fence, the alarm operates in the same manner as if any door or window were opened in the buildings.

The gates were wired by fastening a single strand of insulated wire across the gate. The bare end of this wire is slipped into a spring clip on the post connected to wire along above the fence to complete the circuit, when the gate is closed.

If the range needs protection during the day when the building alarm is not needed, a switching device must be installed allowing the building circuit to be shorted and thus connecting the range loop directly to the panel.

If bare copper wire is used and the side of the transformers connected to the panel is grounded, the alarm will ring when the wire is pushed against the fence and grounded. This has been advocated by some State Agricultural Engineers, but the trouble of insulating from the posts and stretching the wire so it will not blow against the fence and ring the alarm needlessly, really makes the installation quite a problem. (*State Fund*)

Rural Electrification

Through the agency of the State Rural Electrification Committee, on which is representation from the electric utilities, Farm Bureau and Agricultural Engineering Department of the University, cooperation with the Public Service Commission was obtained which resulted in

the formation and adoption by most utilities in the state of a uniform method and procedure of making rural electric line extensions.

The filed regulations governing extensions provide for customers in two groups according to the distances involved, namely; 300-2500 ft., and 2500-5000 ft. The monthly guarantee, for a period of 60 months, is established as 1½% of total cost of construction. Provisions for apportioning the total amount of guarantee among customers, minimum monthly charges, and requirements of additional customers requesting service from new lines are made.

Further activity on the part of the State Rural Electrification Committee brought about the development and recommendation of a modern design and size of electrical entrance for farms in New Hampshire. The experience in rural service to date shows a need for greater capacity than has been provided for, in many cases, in the past. The features are concentric cable, outside metering, and safety switches.

The scale of costs for rural line extensions were revised to present price levels after study of the possible changes in design of line were completed. A change in design of line construction whereby the average span between poles was extended to 200 feet with 250 feet as maximum was recommended. Joint construction (telephone and electric line occupying the same pole) was continued as a construction policy, using 30 ft. Class 6 poles. The price level, for an average mile of line was thereby reduced from the published figure of January, 1933, of $1280.94 to slightly over $1100.00 for 1936.

The Station agricultural engineer, W. T. Ackerman, served as chairman of the State Rural Electrification Committee appointed by the governor to represent in the state in negotiations and conferences with the Rural Electrification Administration in Washington; as a member of the Technical Committee on Power and Power Distribution of the state Planning and Development Commission; and in an advisory capacity to State Comptroller on electric power requirements of isolated state institutions. (*State Fund*).

Dairy Farm Efficiency Study

The economic study of 38 dairy farms in the Colebrook area showed average gross receipts in the year ending December 31, 1934, of $2624. Gross receipts were depressed somewhat by the exceptionally low price of potatoes which is a commercial crop on most of these dairy farms. The average marketable crop of 1346 bushels sold for approximately 20 cents per bushel.

On the basis of a normal price for that locality the gross income would have been increased by over $200. Milk sales averaged $1501 or about 57 per cent of the total income. Thus the farmers in this dairy group depend on other than market milk for nearly half of their gross income.

In this year the average income was low, and no individual had a high income. The conditions were so adverse that some of the larger farms with hired help were at a disadvantage as compared to family-sized farms.

Receipts

Milk	$1501.00	
Eggs	61.75	
Livestock and Meats	293.75	
Feed Crops	16.00	
Cash Crops (mostly potatoes)*	297.60	
Forest Products	153.00	
Miscellaneous	301.00	
Total		$2624.10

Expenses

Hired Labor	$ 295.20	
Purchased Feed	588.80	
Livestock and Veterinary	70.33	
Seed, Fertilizer, Etc.	199.80	
Truck Expense	126.90	
Machinery Repairs, Etc.	71.50	
New Buildings, Etc.	49.40	
Taxes and Insurance	203.75	
Miscellaneous Expense	165.70	
Decrease in Value of Livestock	42.10	
Decrease in Value of Machinery	91.00	
Decrease in Value of Feeds and Supplies	29.80	
Depreciation of Buildings	80.10	
Total Farm Expenses		$2014.38
Farm Income		$ 609.72
Interest (if estimated at 5% on present values)		$ 393.90
Labor Income		$ 215.82

On many farms in the Colebrook area present cropping practices are not designed to keep the farm as a whole functioning economically. While certain fields are brought up to a high state of production, others are declining in productive capacity. Later when the less productive fields are built up, the others decline. The operator under present practices is continually facing the building up of fields that have declined in fertility.

Most farms of the area are adaptable to a system of cropping that would tend to maintain all the tillage fields at a reasonable level of production, and the total production of the farm would be increased. In addition, this sets the stage for a gradual upward spiral in the productive capacity of the soil. The study was made by H. C. Woodworth and A. Hangas. (*Purnell Fund*)

Cod-Liver Oil Helps Calf Feed

Preliminary results in a study of dry-feed systems of raising calves indicate that a satisfactory substitute for whole milk is available in the

*The potatoes on hand December 1 were included under sales at market price at Colebrook.

form of cod-liver oil concentrate, reports K. S. Morrow. Feeding facilities limited the number of calves, and restriction to the University herd involved different breeds; but an attempt was made to have all calves in a group as near the same age as possible.

Four groups were fed varying rations with the following results to age of 180 days: Group 1, cod-liver oil concentrate added to grain mixture at rate of 5 lbs. per ton, average daily gain, 1.55 lbs.; Group 2, commercial calf starter, average daily gain, 1.17 lbs.; Group 3, check ration, average daily gain, 1.51 lbs.; Group 4, special calf starter, average daily gain, 1.29 lbs.

Since the rations used are representative of methods of feeding on New Hampshire farms, it is planned to continue the study until more definite comparisons can be made. (*State Fund*)

Pastures Affect Milk Solids

Further indication that the quality of pastures has a material bearing upon the solids-not-fat content of milk is evident. The number of herds from which 15-day composite samples were drawn was increased from 40 to 57 during the year, reports H. C. Moore. A comparison with the previous year's records shows that while the average fat content ran a little higher and the solids-not-fat content a little lower, the lines seem to go up and down at about the same time both years. The figures check with observations that pastures were not generally so good as last year. Monthly three-day composite samples from the University herd also show the curves for both years reaching the same general high and low points.

While our data does not yet cover so large a number of samples as that used in the Kelly and Clement table of the normal relationship of fat to other solids in milk, the indications are: (1) that the milk from New Hampshire farms does not show the average relationship given in this table; (2) that the milk coming from a large percentage of our farms contains a lower total solids content for the fat test than is given in that table during part of the year; and (3) that regulatory bodies should take into account the fact that normal milk varies in composition at different seasons of the year.

Work is in progress with individual producers to see if this condition is a normal characteristic of the cow, or if by changing feeding and farm management practices, the composition of the milk can be kept normal during the year and possibly raised to relationship expressed in the Kelly and Clement table.

Tests of 37 cows affected with mastitis showed a per cent fat of 3.320 as compared with 3.425 for 19 clean cows; and a per cent solids-not-fat of 8.175 as compared with 8.519.

A paper on our study was presented at the meeting of the American Dairy Science Association in June, 1936. (*Purnell Fund*)

Fruit Bud Formation

Rather strikingly improved fruit bud formation in McIntosh trees that had become biennial in bearing habits, has been obtained by early

thinning. These results were reported by G. F. Potter in a paper to appear in the Proceedings of the American Society for Horticultural Science for 1936. Tests with Baldwin, begun in 1936, include thinning of the blossoms and early thinning of the fruit. The treatments reduced the crop of 1936 considerably, but improved its quality. The effect on blossom bud formation will be determined early in the season of 1937.

A second series of plots containing McIntosh and Spy apples are being treated with different summer sprays. According to results of other investigators, trees sprayed with lime sulphur solution should have a lower rate of photosynthesis than those sprayed with more mild forms of sulphur. Nevertheless at the close of the third season of spraying with these materials, there has been no significant effect on the percentage bloom. Records of the size and color of fruit, per cent of crop to drop before harvest, shoot growth and trunk diameter increase, as yet show no significant differences due to the spray treatment. (*Adams Fund*)

Pollination of Apples

Data on the cross pollination requirements of McIntosh, Cortland, Melba, Milton, Early McIntosh, and Macoun have been summarized by L. P. Latimer in a paper appearing in the Proceedings of the American Society for Horticultural Science for 1936. Of these, the Melba, on which about a 23% set was obtained with self-pollination, is the only variety even partially self-fertile. Fruit from self-pollinated blossoms was smaller than that resulting from cross-pollination. A satisfactory set on any of these varieties can be obtained by pollinating with any other except that Cortland and Early McIntosh will set no fruit when crossed with one another.

Further tests indicate that pollen gathered by bees does not effectively pollenize flowers which they may visit a day or two later. (*Purnell Fund*)

Pruning Experiment with Apple Trees

Two tests are in progress under this project conducted by G. F. Potter. A block of McIntosh and Spy trees planted in 1919 was divided into three plots, in one of which the trees are pruned to the vase form, in the second to the semi-leader type of head, and the third to a full leader type. The results over a period of 17 years have been remarkably uniform. Up to this time, no appreciable breakage has occurred in any of the plots. Yields have been almost identical. With McIntosh the vase form trees have an average yield for the period from 1925 to 1936 inclusive, of 195 pounds per tree per year; the semi-leader 202, and the full leader 197. Corresponding figures for the Spy, covering the period from 1930 to 1936 inclusive, are for the vase form 270, semi-leader 297, and the full leader 294. Average annual twig growth and increase in trunk diameter has not varied significantly in the different plots. Without doubt, in a period of 50 or 60 years, the modified leader type of head will prove the strongest. These results indicate that it may be obtained without any measurable loss in growth or production.

In an orchard planted under sod mulch in 1926, where all of the trees are pruned to a modified leader type, two degrees of severity of pruning have been under test for five years. The difference between the heavy pruned and the light pruned plots is not great. Differences as great or greater exist between different commercial orchards pruned according to the ideas of their individual owners. In walking through the orchards, the difference between the heavily pruned and the lightly pruned rows is not at once obvious, but a careful observer can distinguish the two. The average annual weight of wood removed per tree for the five year period ending in 1936 is for McIntosh 4.8 pounds on heavily pruned trees and 2.7 on the lightly pruned; for Baldwin 4.4 on the heavy pruned, 3.1 on the light pruned; for Starking 5.9 on the heavy pruned, and 3.7 on the light.

While these differences are not large, they are definitely reflected in the yeilds per tree. The average yield per tree for the years 1934, 1935, and 1936 is for McIntosh heavily pruned 109 pounds, lightly pruned 150; for Baldwin heavily pruned 25 pounds, lightly pruned 32; Starking heavily pruned 79 pounds, lightly pruned 91. These averages are all low because frost partially destroyed the crop of 1936. The size of the apples is slightly but consistently larger on the heavily pruned plot, and in the case of the McIntosh the color is significantly lower. In July, 1936, leaf area per bearing spur was determined on a random sample of trees from each plot, but showed no significant differences. (*Hatch Fund*)

Variety Tests of Fruit

Grapes. In a vineyard planted in 1927 it has been found by L. P. Latimer that up to the present time, Worden, Niagara, and Caco are the most satisfactory black, white, and pink varieties respectively. They are certain to mature the fruit before frost, have good quality, and high annual yield. The Ontario, ripening two or three weeks ahead of these varieties, has proved a satisfactory white grape. Winchell, a small white grape of high quality, is satisfactory for home use, although the vines are somewhat weak in growth because of susceptibility to diseases and possibly to winter injury. Many varieties have been unsatisfactory because of lateness of maturity of the fruit, low productivity, or low quality. Herbert and Campbell's Early are not to be recommended. Concord has ripened its fruit only in half of the years.

Of the hardier kinds of grapes, Beta has been outstanding because of its superior quality, high yield of good sized clusters of fruit, and great resistance to diseases. It is highly recommended for the colder sections of the state where grapes of the Labrusca type do not thrive. Although not truly a table grape, excellent jelly, grape juice, and wine can be made from this variety. Portland has been discarded. The vines were too weak and all have died.

Raspberries. Viking has been discarded because of its susceptibility to mosaic and winter injury. Chief has yielded large annual crops, but the softness of the fruit makes it undesirable, commercially when in competition with Latham. For home use, local markets, and roadside stands it is promising. No variety seems more resistant to winter in-

jury, and it is not very susceptible to mosaic. Newburgh was planted in 1935. The growth is vigorous, and the plant seems resistant to mosaic. It has not fruited yet. All canes were winter-killed during the winter of 1936-37.

Plums. Bradshaw, which produces large handsome deep purple or blue fruits, is one of the most promising European varieties on trial. Lombard comes next with good production but somewhat less attractive appearance. The Green Gage plums, Washington and Jefferson, are of fine flavor, but yield rather light crops of fruit. The Japanese sorts, Burbank and Abundance, continue to yield well, but are of low quality.

Sweet Cherries. The Yellow Spanish continues to be the most dependable sweet cherry at the Experiment Station. It withstood the severe winters of the past few years, especially the winter of 1933-34, better than other varieties. Bing recovered sufficiently to produce a good crop of excellent fruit in 1936. Cold has killed most of the Governor Wood trees.

Sour Cherries. Montmorency still seems to be the most desirable sour cherry, and has one of the mildest flavors of this type. Early Richmond ranks second. (*Hatch Fund*)

Nitrogen Versus Complete Fertilizer in the Orchard

Tests of a complete fruit fertilizer of 7-8-5 composition versus a fertilizer carrying the same quantity of nitrogen but no phosphorus and potash were continued by G. F. Potter and G. P. Percival in the cultivated McIntosh orchard at the University farm and under sod mulch in the White orchard at Pittsfield. In the White orchard, the complete fertilizer has increased the growth of mulch. Undoubtedly this will ultimately benefit the trees. To date, however, the average yield per tree for the period of the experiment in both these orchards is slightly less for the trees on which the complete fertilizer is used than for those to which nitrogen only is applied. It is possible that this is due to the fact that the nitrogen in the complete fertilizer is in a less available form. In the White orchard, the color of the fruit has been slightly better and the percentage set slightly lower on the complete fertilizer plots. However, when examined statistically, these differences appear no larger than might be caused by uncontrolled fluctuating factors. In the plot at Durham, these differences in color and set do not exist. In neither orchard is there a significant difference in the size of the apples, the percentage bloom, or the average annual shoot growth.

The experiment was extended in 1935 and 1936 to include 5 new orchards in the Connecticut Valley and in central and southern New Hampshire, where it is thought that the trees may respond to additional supplies of potash. In each case, 10 or 12 trees were fertilized with nitrogen only and other similar trees were fertilized with an equal quantity of nitrogen plus some potassium. The carrier used on most of these trees was chemical potassium nitrate, containing 14% nitrogen and 44% potash. In one orchard a Chilean mixture of nitrate of soda and nitrate of potash was used which has a composition of 14% nitrogen and 14% potassium. The potassium was applied in early spring on the surface

of a sod mulch. Later one orchard was partially disced. In July and August, soil samples were taken at various depths and the extent to which the potassium had been fixed in the surface soil or had penetrated to deeper levels, was determined. The results indicate that in almost all the orchards, the potassium had entered the soil layers between two and four inches beneath the surface, and in the Morton orchard at Plymouth, N. H., a very definite increase in the test for replaceable potassium was obtained in the soil sample 4 and 6 inches beneath the surface. This penetration is rather better than was expected in a sod mulch orchard. Further tests showed that by August in four of the five orchards the petioles of leaves from the potassium plot seemed richer in replaceable potash than those of the nitrogen plot. Two of these orchards were included in the experiment because of a rather serious leaf scorch similar in appearance to the leaf scorch found in potassium deficient apple trees. In the orchard where scorch was most serious, 20 pounds per tree of muriate of potash was applied in May and June, 1935. By August, 1936, the tests for potassium in the petioles of the leaves were distinctly and unquestionably higher where the potash had been applied. However, there was no improvement in the scorch. This seems to indicate rather conclusively that in this instance the trouble is not lack of potassium. (*Hatch Fund*)

Strawberry Fertilizer Tests

In 1935, Howard 17 strawberries were set in a field in which 20 tons of barnyard manure per acre had been cultivated into the soil. On August 7, 1935, each of the following fertilizer treatments was used on 60 separate rows or plots: (1) acid phosphate, 1500 pounds per acre, (2) acid phosphate 750 pounds per acre, (3) and (4) check—no fertilizer. There was no significant difference in yields which totalled: Series 1—61.3 kilograms; Series 2—63.4 kilograms; Series 3—60.1 kilograms; Series 4—62.9 kilograms. It seems certain that as great a yield was obtained with manure alone as when acid phosphate was applied in addition, reports L. P. Latimer. (*Hatch Fund.*)

Variety Tests of Vegetables

A test of 27 hybrid *sweet corn* varieties was made by J. R. Hepler from seed planted May 27.

The Golden Cross Bantams, especially the Purdue strains, are the standards for their time of maturity.

Of the early hybrids Gemcross 39 and Spancross 39 were most promising. Double Cross Bantam 44073 was a small eared high quality early corn. Sencross 7 x 43-5 and the 3 Way x 43-29 were promising crosses considering quality, size, and type of ear and time of maturity.

In the *tomato* variety trials, the variations between strains of the same variety have proved almost as great as between varieties. Of the Earliana types, Canadian (Harris) and Sunrise (Landreth) gave the largest yields last year; of the Bonny Best types, the Landreth strains of Bonny Best and John Baer; of the Stone types, No Substitute; and of the Marglobe group, the Stokes strain. Yields from three strains of Bonny Best ranged from 8.2 to 17.8 lbs. of ripe fruit per plant.

Certain strains like the variety Landreth and the Shirley and Landreth Bonny Best have consistently yielded well at the Horticultural Farm. (*Hatch Fund*)

Fertilizers in the Peach Orchard

The bearing trees in the peach orchard have been divided by G. F. Potter into five plots, on three of which nitrate of soda is applied at the rate of 4 pounds per tree, and on the remaining two at the rate of 2 pounds per tree. A full crop of peaches was harvested in 1936, but practically no difference was observed in the total yield or the per cent of drops. The trees having high nitrogen had an average yield of 107 pounds per tree with 11.2% drops. Those with a low nitrogen had an average yield of 102 pounds per tree with 10% drops. (*Hatch Fund*)

Protein Requirements of Chickens at Various Stages of Growth and Development

Twelve groups of laying pullets, fed varying levels of protein derived from three animal protein sources, namely, fish meal, dried skim milk, and meat scrap, were maintained in laying cages up to seventy weeks of age.

Comparisons between groups were made on a basis of body weight, feed consumption, efficiency of feed consumption, egg production, egg weight, and mortality. Inasmuch as this report is one of progress and not of final conclusion, definite statements concerning results secured are being withheld until at least one additional year's work is completed covering a repetition of the previous work. Tentative conclusions advanced to date are as follows:

1. No relationship appears between percentage protein content of feed and total feed consumed.

2. Body weight of birds within all groups did not advance regularly as age increased, but was subject to occasional weekly decreases.

3. The groups fed fish meal as the sole source of animal protein were most efficient in feed consumption, as measured by number of pounds of feed required to produce one dozen eggs. The groups receiving dried skim milk were least efficient.

4. Mortality was relatively heavy. Those groups receiving dried skim milk as the sole source of animal protein experienced the lowest mortality.

5. The groups receiving fish meal as animal protein supplement averaged to lay at the greatest rate of production with the mixture, meat scrap and dried skim milk groups following in the order named.

6. No significant relationship appears between percentage protein fed and size of egg laid. The work was conducted by A. E. Tepper, R. C. Durgin and T. B. Charles. (*Purnell Fund*)

Vitamin "A" Requirements of Growing Chicks at Various Stages of Development

To determine the Vitamin A requirements of growing chicks in terms of Vitamin units for optimum weight gains and high livability, twenty pedigreed sex-linked pullet chicks were maintained in individual cages over a six week period. The twenty chicks were equally divided into five groups and fed rations of varying Vitamin A content as follows:

Group 1—Basal Ration (Deficient in Vitamin A)

Group 2—Basal Ration plus oral feeding of 33 U.S.P. x (1934) A Units daily.

Group 3—Basal Ration plus oral feeding of 99 U.S.P. x (1934) A Units daily.

Group 4—Basal Ration plus oral feeding of 165 U.S.P. x (1934) A Units daily.

Group 5—New England College Conference Formula

The results secured over the six weeks feeding period substantiate the following statements, report A. E. Tepper and R. C. Durgin. (*Purnell Fund*)

1. Increased Vitamin A consumption tends to increase feed consumption.
2. There appears to be a relatively hifih Vitamin A requirement during the initial starting period.
3. The Vitamin A consumption per 100 grams of feed consumed for most economical results should be at least 108 U.S.P. x (1934) units. (*Purnell Fund*)

Technique for the Eradication of Pullorum

A comparison of the efficiency and accuracy of the whole blood stained antigen test for pullorum and the standard tube test was made by C. A. Bottorff in twelve flocks selected on their history of possible infection. There were 15,304 birds tested and only 63 reactors were found —one in one flock and 62 in another. The owner of the flock having the large number of reactors decided against additional testing. In this one case, the whole blood method picked out 42 reactors, and the standard tube test 62 reactors. The remaining ten flocks all passed negative.

As a result of this work, it is recommended that the standard tube test continue to be used for the official test in New Hampshire.

Control of Coccidiosis

Studies were made of various parts of the chicken's digestive tract to determine the normal pH and the influence of feeding different alkalis and acids. No variations of significance in the study of coccidiosis, however, were found.

The influence of feeding and litter treatment on chronic coccidiosis was also investigated. A pen started with hard grain feeding along with the mash was compared with a pen that was not fed hard grain for the first four weeks; and both pens were compared with others in which the litter was treated and the birds fed according to recommended practice. No coccidiosis developed, but mortality and culling were lower in the litter-treated pens. The pens were kept dry at all times, and the results tend to confirm other observations that there is much less trouble with the disease in dry pens. Half of the birds were placed in batteries, and egg records of these were much lower than for the birds kept in pens.

Another group of birds was divided into six pens of 20 birds each. In five pens three birds were treated periodically with oocysts of chronic coccidia, receiving otherwise different rations and treatments. Again all pens were kept dry, however, and the disease did not develop. Records of egg production from October to April show considerable variation as follows:

Control Group, no oocysts		2045 eggs
Oocyst Groups:	Litter treated with sulphur weekly	1879 eggs
	2% sodium bicarbonate in feed	1742 eggs
	5% sulphur in feed	1529 eggs
	10% milk sugar in feed	1233 eggs
	Regular feed	1214 eggs

The work was in charge of C. L. Martin, T. B. Charles, R. C. Durgin and S. R. Shimer. (*Purnell Fund*)

Epidemic Tremors of Chickens

Our studies of epidemic tremors, the trembling chick disease, were reported at the World's Poultry Congress in Berlin, Germany, in August, 1936, and a summary has been published in Station Circular 51. The results indicate that the disease is not hereditary; that it may occur under different types of brooding and feeding systems; that it does not appear to be caused by variations in incubation or hatching temperatures; and that affected birds show no significant difference in body temperatures or blood counts. Transmission studies have thus far failed to indicate how the disease spreads. The work is handled by C. A. Bottorff, A. E. Tepper, T. B. Charles and R. C. Durgin. (*Purnell Fund*)

Vaccinating for Bang's Disease

Cattle from the age of two months to four years were vaccinated by C. L. Martin with an attenuated Bang's disease vaccine from both Federal and commercial sources. The purpose was to find out if cattle so vaccinated would later give a negative reaction to the standard tube agglutination test for Bang's disease, and how long after inoculation they would give a positive reaction.

Tests showed that all animals vaccinated gave a strong postive reaction one month after inoculation. Previous to vaccination two blood tests were made to find out the reaction of blood. (*Purnell Fund*)

Pullorum Tests

The largest number of blood samples tested for pullorum for any testing season since the work was started in 1918 occurred during the season 1935-36, reports C. A. Bottorff. There were 284 poultrymen who tested 370,176 blood samples from 336,417 birds. This number is more than 30% of the total adult poultry population of the state, and 99.81% of the samples tested did not react to the test. This high percentage of freedom from pullorum is one of the contributing factors of the present high standing of the poultry industry in New Hampshire.

The 50 per cent increase in the number of tests has, in a large measure, been due to reduction in costs to the poultryman. The Division of Animal Industry of the New Hampshire Department of Agriculture paid for the laboratory cost, and the poultrymen the cost of collection of the blood samples.

There was an increase of 18 in the total number of pullorum clean flocks, and an increase of 31 in the pullorum passed flocks.

Reactors were found in 38 flocks.

The fact that pullorum can be eradicated by use of the agglutination test and the maintenance of a clean flock through annual testing is shown by the fact that 8 flocks testing 100% of the birds have passed 12 consecutive years without any reactors, 7 for 11 consecutive years, 9 for 10 consecutive years, 8 for 9 consecutive years, 6 for 8 consecutive years, 14 for 7 consecutive years, 23 for 6 consecutive years, 35 for 5 consecutive years, 5 for 4 consecutive years, 19 for 3 consecutive years, 36 for 2 consecutive years. (*Miscellaneous Income*)

Poultry Autopsies

During the fiscal year 2,143 poultry autopsies were performed in the poultry pathology laboratory by C. L. Martin and C. A. Bottorff. There were 831 adult chickens, 1,245 chicks, 66 turkeys and one duck autopsied for the poultrymen in the state.

The principal diseases in adults were ruptured egg yolk 29.8%, coccidiosis 16.4%, indigestion 15.6%, uremia 8.54%, pneumonia 8.42%, tumors 5.9%, round worms 5.8%.

The principal chick diseases were pneumonia 24.3%, coccidiosis 18.0%, ulcerated gizzard 17.0%, pullorum 13.0%, indigestion 9.3%, epidemic tremors 5.7%. (*State Fund*)

Fowl Pox Vaccine Distribution

The total number of doses of Fowl Pox vaccine distributed to New Hampshire poultrymen during the fiscal year was 256,200, an increase of 31,000 doses over the previous year's distribution.

Shortly after the start of this year the Station decided not to sell any more vaccine outside the state. (*Miscellaneous Income*)

Laryngotracheitis Vaccine Distribution

During the past season 75,400 doses of Laryngotracheitis vaccine were distributed to poultrymen in New Hampshire. This vaccine was

used in only four of the ten counties of the state. Its distribution was carefully supervised, and no vaccine was allowed to be used except for: (1) a properly diagnosed outbreak; (2) where an outbreak had occurred the previous year; (3) where a flock had been vaccinated the previous year; or (4) where one flock, of two closely adjoining flocks has been vaccinated due to an outbreak. (*Miscellaneous Income*)

Bang's Disease Testing

The total number of samples tested for Bang's Disease in 1935-1936 was 27,998, reports C. L. Martin. This included 23,823 Federal, 1,229 private and 2,946 out-of-state samples. This was an increase of 13,733 samples—due to the Federal work. The percentage of positive reactors was the same as last year—8.36%. (*Miscellaneous Income*)

Record of Performance and Poultry Approval

Record of Performance work is officially supervised trapnesting and breeding on poultry breeding farms. The supervisor, a representative of the Experiment Station, makes eight annual visits to each farm giving it official recognition, and assisting the poultryman in his breeding problems. Record of Performance certificates are issued for birds producing 200 or more 24 ounce eggs, and Advanced certificates are given for birds laying 240 or more standard sized eggs.

The Record of Performance Association has ten members (two of Barred Rocks, one of White Rocks and seven of New Hampshires.) The Association has affiliated itself with the National Poultry Improvement Plan, which should stimulate further interest in R.O.P. R. C. Durgin is in charge.

Poultry Approval, which was formerly called Poultry Certification, has also become one of the steps in the National Poultry Improvement Plan. This stage entails the handling of a flock of birds by the inspector who grades the birds into two classes, breeders and culls. The superior individuals as to type, color, producing qualities and freedom from inherited disqualifications, are held for breeders.

There will be about 50,000 U. S. Approved birds on at least 35 New Hampshire farms during the breeding season of 1937-38. (*Miscellaneous Income*)

Inspection Service

Feeding Stuffs Inspection. In the enforcement of the law regulating the sale of concentrated commercial feeding stuffs, 384 brands were analyzed for the State Department of Agriculture. The analyses required about 2900 individual determinations.

Fertilizer Inspection. In the enforcement of the law regulating the sale of commercial fertilizers, 106 brands were analyzed for the State Department of Agriculture. These analyses required about 750 determinations.

Cooperation with the Smalley Foundation has been continued by the analysis of some 30 samples. The results show that our laboratory is maintaining its high standard of accuracy.

The laboratory has also cooperated with a referee of the Association of Official Agricultural Chemists in a study of methods for determining the residual acidity or basicity of fertilizers. Some 40 samples were analyzed in this connection. The work is conducted by T. O. Smith and H. A. Davis. (*Miscellaneous Income*)

Soil Tests. The testing of soils for residents of the state has been continued. From July 1, 1935 to June 30, 1936, 983 soils were received and tested by G. P. Percival and P. N. Scripture. During the previous year the number was 650. The receipt of samples for testing still continues to increase.

Seed Inspection. The regular seed inspection work for the State Department of Agriculture was conducted as usual. During the year 487 samples of seed were handled in the laboratory. Of this number 430 were collected by the State Inspector and are reported in Bulletin 293; the remaining fifty-seven samples were sent in by private individuals. The referee work was done as usual. The work was done by Mrs. Betty G. Sanborn, Seed Analyst, assisted by L. J. Higgins, Assistant Agronomist. (*Miscellaneous Income*)

Feeding stuffs, fertilizers and other miscellaneous materials to the number of 38 have been analyzed for residents of the state. About 150 individual determinations have been made on these samples. There has been, also, a considerable volume of correspondence relating to inquiries not involving analyses. (*Miscellaneous Income*)

Seed Certification. Eighty-five acres of Green Mountain potatoes were entered for certification and the entire acreage passed all inspections, reports O. Butler. The mean yield was 306 bushels per acre, the lowest obtained since 1932. Besides the Green Mountain there were also entered for certification 11 acres of Irish Cobbler, but only 6.5 acres passed final inspection. (*Miscellaneous Income*)

FINANCIAL STATEMENT

Expenditures of the New Hampshire Agricultural Experiment Station for the Year Ending June 30, 1936

	Federal Funds				Bankhead Jones Offset	Supplementary*	Total
	Hatch Fund	Adams Fund	Purnell Fund	Bankhead Jones			
Personal services	$10,841.92	$13,271.02	$49,145.86	$1,706.12	$2,089.30	$21,838.85	$ 98,893.07
Supplies and materials	498.31	579.90	3,048.92	180.44	.....	4,604.03	8,911.60
Communication service	971.61	.....	67.09	.05	.....	578.34	1,617.09
Travel expenses	416.85	110.49	3,239.77	49.14	.....	4,095.41	7,911.66
Transportation of things	306.71	47.41	100.86	15.98	.....	123.92	594.85
Publications	652.82	.....	559.26	.....	.....	205.27	1,417.48
Heat, light, water, and power	700.93	.....	1.21	.....	.....	160.98	863.12
Contingent expenses	2.28	1.71	44.61	.....	.....	9,795.47	9,844.07
Equipment	608.57	820.30	3,619.15	122.57	.....	1,650.86	6,821.45
Buildings and land	.....	169.17	173.27	15.00	.....	2,156.56	2,514.00
Balance	.....	.....	.....	.....	.....	13,004.81	13,004.81
Totals	$15,000.00	$15,000.00	$60,000.00	$2,089.30	$2,089.30	$58,214.60	$152,393.20

*This fund includes expenditures from the following sources:

State appropriations	$ 3,584.20
Sales and miscellaneous income	54,630.40
	$58,214.60

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